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3 Preliminary

3.1 General

The following series of articles provides a set of guidelines for development of type, size, and location (TS&L) plans for bridges, walls, and culverts that require final design. The TS&L plans will include a Preliminary Situation Plan and may additionally include Site Plan or Miscellaneous Detail sheets. ~~TS&L plans are of two types: (1) Preliminary Situation Plans for bridges, walls, and culverts that require final design and (2) Pipe Plat Plans for pipe culverts.~~ Within the guidelines and throughout the development of TS&L plans it is important that the designer apply sound engineering judgment, including technical and economic analysis. For additional information on culvert design, see BDM Chapter 4.

Additional information regarding preliminary design is also contained within BDM Chapter 1.~~2.~~

3.1.1 Policy overview

Within the Office of Bridges and Structures, the preliminary bridge design section develops the preliminary layouts for highway structures. For bridges, walls, culverts, and miscellaneous structures that require final design, the section assembles information and develops TS&L sheets ~~a preliminary situation plan sheet~~ so that a designer in one of the final design sections can perform the structural design and develop final plans for a contract letting. ~~For pipe culverts the section develops the layout in sufficient detail that the Office of Design can reference the information on their final road plans for a contract letting.~~

The development of all preliminary structure plans includes a number of tasks such as:

- Analyzing hydrology and hydraulics;
- Analyzing road geometrics;
- Determining the type, size, and location of structures;
- Developing a layout in the CADD system;
- Attending field reviews;
- Coordinating with other Iowa DOT offices, public entities, and outside agencies;
- Estimating cost alternatives;
- Obtaining flood plain permit approvals;
- Coordinating with other regulatory agencies; and
- Consideration of accelerated bridge construction (ABC).
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3.1.2 Design information

The designer will need to access information from several sources to perform preliminary design, including the following:

- Plans for existing structures, including as-built plans, from Electronic Records Management System (ERMS);

- Bridge maintenance reports from ERMS and SIIMS;
- A new site survey from Office of Design;
- Soil boring information from the Office of Design;
- Aerial photographs from the Office of Design and/or web sites;
- Aerial agricultural photographs (drainage maps) from the Photogrammetry/Preliminary Survey Section in the Office of Design;
- Topographic maps from the Office of Bridges and Structures, the Office of Design and/or web sites; and
- Field exams.

Plans for existing structures will give a good indication of the site when an existing structure was built, widened, and/or extended, and comparison with a new survey will indicate any site changes that have occurred since previous construction.

The designer should make appropriate use of CADD to integrate support programs such as Geopak and GeoMedia when developing type, size, and location (TS&L) plans.

3.1.3 Definitions

Annual Exceedance Probability Discharge (AEPD) is an estimate of the flood discharge for the annual flood frequency recurrence intervals as determined by a regional regression analysis method described in USGS SIR 2013-5086.

Average low water is the water level expected during a normal season and may be defined by the vegetation line along a stream bank or by the base flow. The average low water can generally be represented by the water surface elevation at time of survey or can be defined as one foot above the average stream bed.

Bridge Backwater is caused by the encroachment of the road embankment onto the floodplain which constricts flood flows through the bridge opening.

Base Flood is the flood having a one percent chance of being equaled or exceeded in any given year. This is the regulatory standard also referred to as the "100-year flood." The base flood is the national standard used by the National Flood Insurance Program (NFIP) and all Federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development.

Base Flood Elevation (BFE) is the computed elevation to which floodwater is anticipated to rise during the base flood. BFEs are shown on Flood Insurance Rate Maps (FIRMS) and on the flood profiles. The BFE is the regulatory requirement for the elevation or floodproofing of structures. The relationship between the BFE and a structure's elevation determines the flood insurance premium.

Berm slope location table (BSLT) gives toe and top of berm information to aid the contractor in construction of the berm.

Bicycle lane or **bike lane** is a portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists.

Censored gage record includes discharges (low and high outliers) and historical flood discharges that the USGS may adjust or integrate for use in peak flow analysis. There are two types of censored data (1) annual peak discharges collected at gage sites for which the discharge is only known to be less than the minimum recordable discharge threshold, or (2) in the case of historical periods, annual peak discharges that are only known not to have exceeded a recorded historical flood discharge.

Check scour is based on the occurrence of a 500-year or lesser flood used to ensure pile capacity and stability will not fail at the extreme scour event.

Detailed Flood Insurance Study (FIS) analysis of a community's flood prone areas which determines the 100 year flood elevation and floodway for certain streams.

Design scour is based on the occurrence of a 200-year or lesser flood used to evaluate pile capacity and stability.

Electronic Reference Library (ERL) contains plans, specifications, and manuals and is available on the Iowa Department of Transportation's web site.

Electronic Records Management System (ERMS) has been developed to enable electronic use and management of documents within the Iowa Department of Transportation. ERMS includes aerial photographs, existing bridge plans, bridge inspection records, and other documents useful for preliminary bridge design.

EMA/MGB is the method used in Scientific Investigations Report 2013-5086 to compute log-Pearson Type III exceedance probability analysis for stream gages evaluated for use in the development of the Iowa regional regression equations. The method allows for the integration of censored (low and high outliers) and historical peak-discharge data in the analysis. This is the method used in the updated Bulletin 17C "Guidelines for Determining Flood Flow Frequency".

Expected moments algorithm (EMA) is an annual exceedance-probability analysis method used for continuous-record stream gages. EMA analysis method needs a consistent statistical test (MGB) to identify potentially influential low flows in an annual peak-discharge series to properly reduce the effect of low outliers.

Extreme highwater is the highest water level recorded for a particular location. Information can be obtained from USGS or Corps flood reports, when available.

Floodway is the portion of the floodplain that must be left unobstructed for the conveyance of the 100 year flood.

Flood Risk Reduction Project (FRRP) is typically defined as a Corps of Engineers designed flood protection levee system.

Freeboard is the vertical clearance measured between the ~~-~~regulatory low beam ~~bottom of the superstructure~~ and the 50 year stage with the proposed bridge in place. Typically this clearance is measured in the middle of the channel at the downstream edge of ~~-~~the proposed bridge.

Grading surface is the finished earthwork surface within the limits of project grading and the existing ground surface outside the limits of project grading. At locations where the finished earthwork surface represents non-earthen materials (rock revetment, concrete block mats, pavement etc.) plan details will define the grading surface relative to these materials. Earthwork quantities are calculated relative to the grading surface. ~~is defined by k~~Key bridge berm grading surface points shall be defined in ~~on~~ the Berm Slope Location Table [BDM 3.2.7.3.3].

~~**Green book** is the office term for the Office of Design's manual of Road Design Details.~~

Inundation of beams occurs when the flood stage reaches the bottom of the lowest beam along the entire bridge (operational low beam).

Mean highwater (MHW) is a term used in the AASHTO Guide Specification for Vessel Collision Design of Highway Bridges and is defined by the Coast Guard as the average of the height of the diurnal (each day) high waters at a particular location measured over a period of 19 years.

Multiple Grubbs-Beck (MGB) test is a statistical method to identify low gage data outliers that depart substantially from the trend of the rest of the annual peak discharge data. Annual peak discharges

identified as low outliers by the method are excluded from the dataset. EMA/MGB exceedance-probability analysis computed for the Scientific Investigations Report 2013-5086 used the MGB test for the development of the skew analysis and the Iowa regional regression equations.

Multi-region basin is a site drainage area that drains more than one hydrologic region (crosses a hydrologic region boundary) as defined by a given USGS methodology for calculating annual exceedance probability discharges.

Operational low beam is the bottom of the lowest beam along the entire bridge for use in identifying the stage in which beam inundation will begin to occur. It may be located on the upstream or downstream side. The elevation shall be documented in the TS&L Hydraulic Data Block and the location shall be shown on the bridge longitudinal section.

Ordinary high water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas [Code of the Federal Register 33 CFR Part 328.3].

Q50 is a flood that has a 2% statistical probability (chance) of being equaled or exceeded in any year.

Q100 is a flood that has a 1% statistical probability (chance) of being equaled or exceeded in any year.

~~**Red book** is the office term for the Office of Design's manual of Standard Road Plans.~~

Regulatory low beam is the bottom of the low beam at the center of channel on the downstream side of the bridge. It is utilized to determine compliance with the Iowa DNR freeboard requirement. The elevation shall be documented in the TS&L Hydraulic Data Block and the location shall be shown on the longitudinal section.

Revetment is a relatively general term for a facing that supports an embankment. **Riprap** is a more specific term for the layer of various sized rocks or broken concrete used to protect a streambank from erosion. With respect to streambank protection the terms **revetment** and **riprap** usually are interchangeable. **Revetment Stone** is the quarry industry's product that may be used for streambank erosion protection.

Section 408 Approval is required from the Corps of Engineers for any project within 300 feet riverward or 500 feet landward of a Corps Flood Risk Reduction Project (FRRP).

Section Leader is the supervisor of the Office of Bridges and Structures preliminary bridge section, final design section, or consultant coordination section.

Shared use path is a bikeway physically separated from motorized vehicular traffic by an open space or a barrier and either within the highway right-of-way or within an independent right-of-way. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers, and other non-motorized users. See AASHTO's 1999 *Guide for the Development of Bicycle Facilities* [BDM 3.1.5.2].

Stage is the water surface elevation for a given discharge. Stage for the purpose of the hydraulic data block is the engineer's best estimate of the PROPOSED water surface elevation at the downstream toe of the road embankment.

~~**Typical** is the office term for a Road Design Detail.~~**Uncensored gage record** includes peak discharge data at given gage site, exclusive of censored record. Uncensored data represents actual observed values, whereas censored data reflects historical or otherwise estimated data values. Statistics

developed using only uncensored data will generally be presented as 'period-of-record' whereas statistics that include censored data generally be presented as 'historical period'.

Weighted Independent Estimate (WIE) is a method for weighting two independent estimates inversely proportional to their associated variances. Annual exceedance-probability discharges (AEPD) by the log-Pearson Type III estimate (EMA/MGB) and the regional regression equations are assumed to be independent and can be weighted by this method and the variance of the weighted estimate will be less than the variance of either of the independent estimates.

3.1.4 Abbreviations and notation

3R, Resurfacing, Restoration, Rehabilitation; a series of terms that refers to a Federal Highway Administration highway project funding program
ADT, average daily traffic
AEPD, annual exceedance-probability discharge
AREMA, American Railway Engineering and Maintenance-of-Way Association
B0, event code for Office of Bridges and Structures concept
B1, event code for Office of Bridges and Structures layout
B2, event code for structural/hydraulic design plans to Office of Design
BTB, BTC, BTD, BTE, standard cross sections for pretensioned prestressed concrete bulb tee beams
BNSF, Burlington Northern Santa-Fe Railway
BSLT, berm slope location table
CCS, continuous concrete slab
CFR, Code of Federal Regulations
CLOMR, Conditional Letter of Map Revision issued by FEMA
CMP, corrugated metal pipe
CWPG, continuous welded plate girder
D_{50}, median revetment stone diameter
D0, event code for predesign concept
D2, event code for design field exam
DA, drainage area
EMA, expected moments algorithm annual exceedance-probability analysis
ERL, Electronic Reference Library
ERMS, Electronic Records Management System
FEMA, Federal Emergency Management Agency
FHWA, Federal Highway Administration
FIS, Flood Insurance Study
HDPE, high density polyethylene
HEC-2, U.S. Army Corps of Engineers **H**ydrologic **E**ngineering **C**enter hydraulic analysis software
HEC-RAS, U.S. Army Corps of Engineers **H**ydrologic **E**ngineering **C**enter – **R**iver **A**nalysis **S**ystem hydraulic analysis software
IAC, Iowa Administrative Code
IFI, intermediate foundation improvement
IHRB, Iowa Highway Research Board
Iowa DNR, Iowa Department of Natural Resources
Iowa DOT, Iowa Department of Transportation
LOMR, Letter of Map Revision issued by FEMA
LP3, log-Pearson Type III
LT, left
M, distance between chord and arc at midpoint of horizontally curved bridge [BDM 3.2.6.3]
MCS, main-channel slope, a variable in USGS WRIR 03-4120
MGB, Multiple Grubbs-Beck low-outlier test
MSE, mechanically stabilized earth, generally associated with retaining walls
N or N-value, standard penetration test number of blows per foot (300 mm). N also may be given as SPT NO, the Standard Penetration Test Number in the soils information chart.

n-coefficient, Manning's Coefficient [BDM 3.2.2.3]
NFIP, National Flood Insurance Program
NHS, National Highway System
NOAA, National Oceanic and Atmospheric Administration
NRCS, Natural Resources Conservation Service
PE, preliminary engineering
PEP, polyethylene pipe
POT, point on tangent
PPCB, pretensioned prestressed concrete beam
Q_2, Q_{50}, Q_{100}, Q_{200}, Q_{500}, estimated channel discharge at 2-, 50-, 100-, 200- or 500-year design flood frequency
RBLT, recoverable berm location table
RCB, reinforced concrete box, a type of culvert
RCP, reinforced concrete pipe
ROW, right of way
RRE, regional regression equation
RSB, rolled steel beam
RSS, reinforced steepened slope
RT, right
SI&A, Structure Inventory and Appraisal
SIIMS, Structure Inventory and Inspection Management System
SIR, scientific investigations report
SUDAS, (Iowa) Statewide Urban Design and Specifications
TS&L, type, size, and location
UP or **UPRR,** Union Pacific Railroad
USGS, United States Geological Survey
WIE, weighted independent estimates
WRIR, water-resources investigation report
WSPRO, water surface profile software developed by the U.S. Geological Survey

3.1.5 References

3.1.5.1 Direct

[IDOT PPM policy number] refers to a policy in the Iowa Department of Transportation *Policies and Procedures Manual.*

[IDOT SS article] refers to Iowa Department of Transportation *Standard Specifications for Highway and Bridge Construction, Series 2009* with article number. (Available on the Internet at: http://www.iowadot.gov/erl/index.html)

[OD DM article, table, or figure] refers to the Office of Design, Highway Division *Design Manual* with article, table, or figure number. (Available on the Internet at: http://www.iowadot.gov/design/dmanual/manual.html?reload)

[OD RDD sheet number] refers to the Office of Design, Highway Division "Road Design Details" with sheet number. Formerly the detail manual was referred to as the "green book." (Available on the Internet at: http://www.iowadot.gov/design/desdet.htm)

[OD SRP sheet number] refers to an Office of Design, Highway Division "Standard Road Plan" with sheet number. Formerly the plan manual was referred to as the "red book." (Available on the Internet at: http://www.iowadot.gov/design/stdrdpln.htm)

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